LATERAL HETEROGENEITY OF THE LUNAR CRUST IN ALPHONSUS REGION.

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We have been interested in the pre-imbrian-aged region of Alphonsus crater (13°S, 2,5°W), located at the border of highlands and mare, and having undergone a complex geological history. This is a good candidate to document fundamental questions concerning the lunar ancient highland crust: formation, evolution, structure, and especially the complexity of these processes. Our work has consisted in a several-steps geological study of the region, mainly based on Clementine UV-VIS multispectral data. A mosaic of the region has been produced in each of the five spectral bands (0.40, 0.75, 0.90, 0.95, and 1.00 μm) at 200 m spatial resolution, and calibrated on the basis of independent spectra (1, 2). These data are also compared to morphological (3) and topographic (4) data, and confronted with previous works (2, 5, 6).

By means of a principal component analysis (PCA), the main geological units present in the region are defined with spectral and regional criteria. Independently, the iron content of the surface is mapped at 200 m resolution, on the basis of Lucey et al.'s calibration of the 0.95/0.75 μm spectral ratio (8). This analysis allows to better constrain the geological units in terms of chemical composition. It shows for instance a strong contrast of iron content between the central peaks of Alphonsus (<4%) and Arzachel (~10%). The principal component analysis also allows to identify nine endmembers, encompassing the whole regional spectral variability (cf. figure 1). These endmembers are related to spectrally coherent specific geological units.

Then is used an iterative spectral mixture analysis, with four combinations of these endmembers, in order to understand the organization of the main geological units. Mare Nubium, a basaltic unit at the south-east of Alphonsus crater, Arzachel floor, Alphonsus eastern walls, Alphonsus floor, and a light-material unit north-west of Alphonsus, correspond to the main regional components that mix with each other, mainly in relation with impact/ejecta events. Alphonsus and Arzachel's central peaks, and the small bright crater on south-eastern walls of Alphonsus, are specific non-mixed features.

This analysis leads to a first attempt at deciphering the regional geology, resulting in the production of a simplified geologic map, and in possible interpretations in relation with the different units setting. These include for instance the extent of the ejected materials due to Arzachel impact, covering more than half of Alphonsus floor, or the presence of the dark halos surrounding some "endogenic" craters on the floor of Alphonsus. According to our study, the composition of these deposits is similar to that of Mare Nubium, and their origin can then be related to this basin filling.

Moreover, an impact having excavated material from 10 to 15 km depth in case of a crater of Alphonsus or Arzachel size (~100 km), it gives somehow an access to a regional cross-section of the lunar crust. Relating the produced spectral mapping to the existing geological units (eg. peaks, crater walls), we propose a regional stratigraphic reconstruction, illustrated by

cross-sections representing the crustal structure.

An obvious crustal contrast appears between the pre-existing targets of Alphonsus and Arzachel craters. At 10-15 km depth, the first site is dominated by anorthosite (cf. figure 1 and (8), (2)), which is found not only at Alphonsus peak but also on the north-eastern walls, while Arzachel site is ruled by norite (cf. figure 1 and (8), (2)), present on the peak and floor- or walls- craters of Arzachel. This contrast is also illustrated by the gap between the iron content ranges of the two structures.

Finally, the present study of Alphonsus region points at the existence of lateral variations in the compositional structure of the lunar crust, at the hundred kilometres scale. It may imply much more complex processes of formation than envisioned at present, involving for instance convective mixing processes and heterogeneous initial stratification.

REFERENCES:

(1) Pieters (1976), Lunar spectroscopic atlas, *unpublished*; (2) Coombs C.R. *et al.* (1990), *LPSC XX*, 161; (3) Ranger IX Photographs of the Moon (1966); (4) USGS Lunar Topographic Map LM77 (1978); (5) Head J.W. and Wilson L. (1979), *LPSC X*, 2861; (6) Zisk S.H. *et al.* (1991), *Geophys. Res. Lett.* 18, 2137; (7) Lucey P.G. *et al.* (1995), *Science* 268, 1150; (8) Pieters (1986), *Rev. Geophys.* 24, 557

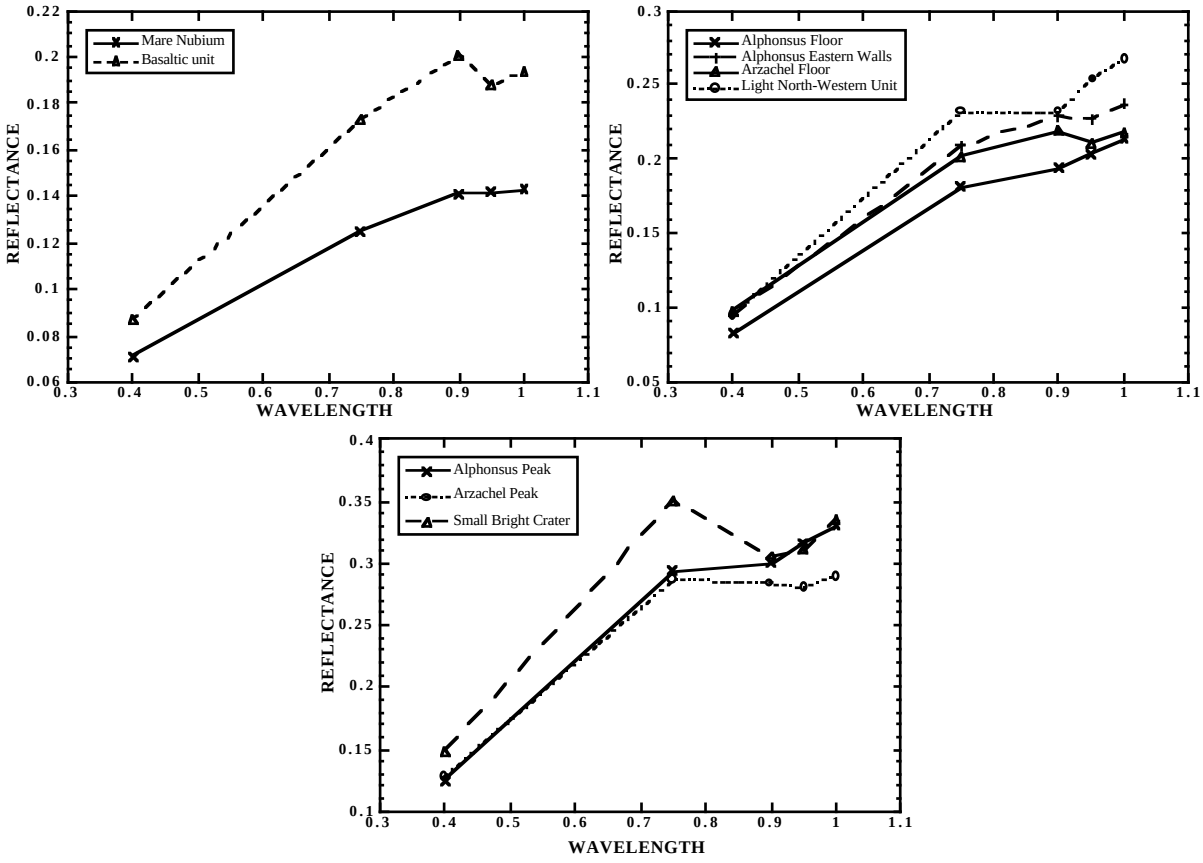

Figure 1: Clementine spectra of the nine selected endmembers.